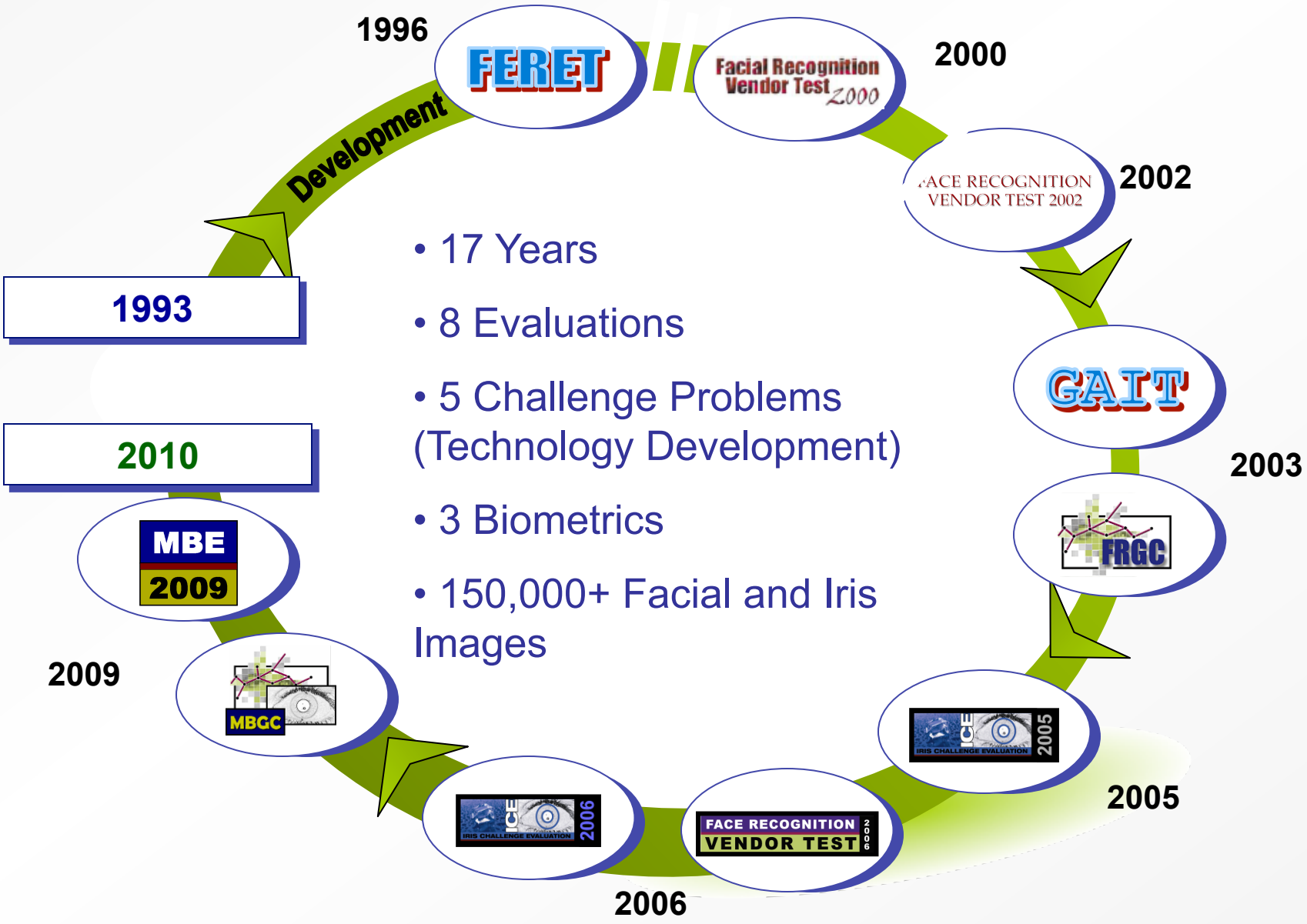
Using Challenge Problems To Accelerate Biometric Technology

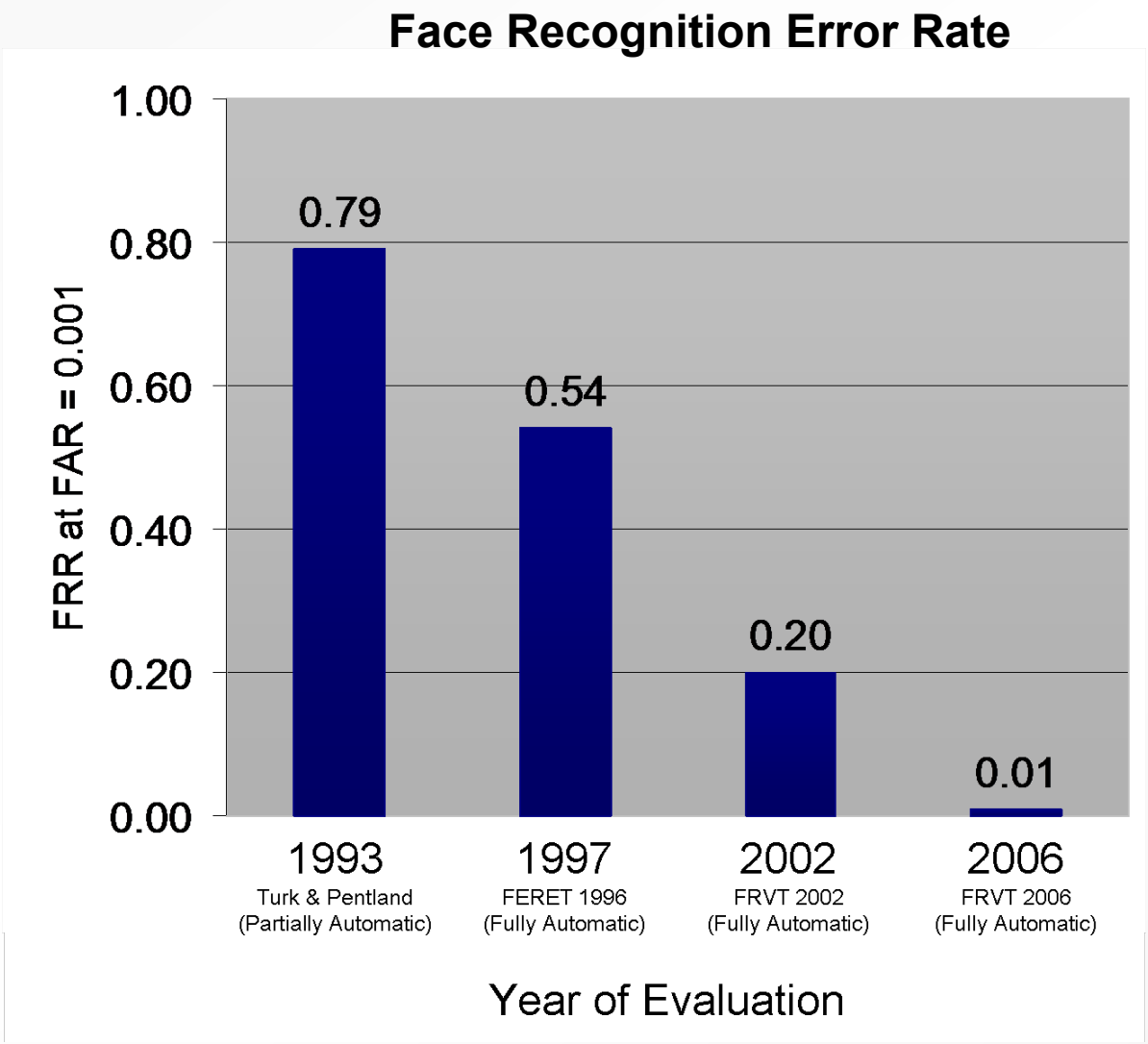
Dr. P. Jonathon Phillips

National Institute of Standards and Technology

Technology Progress



Improved FR Performance

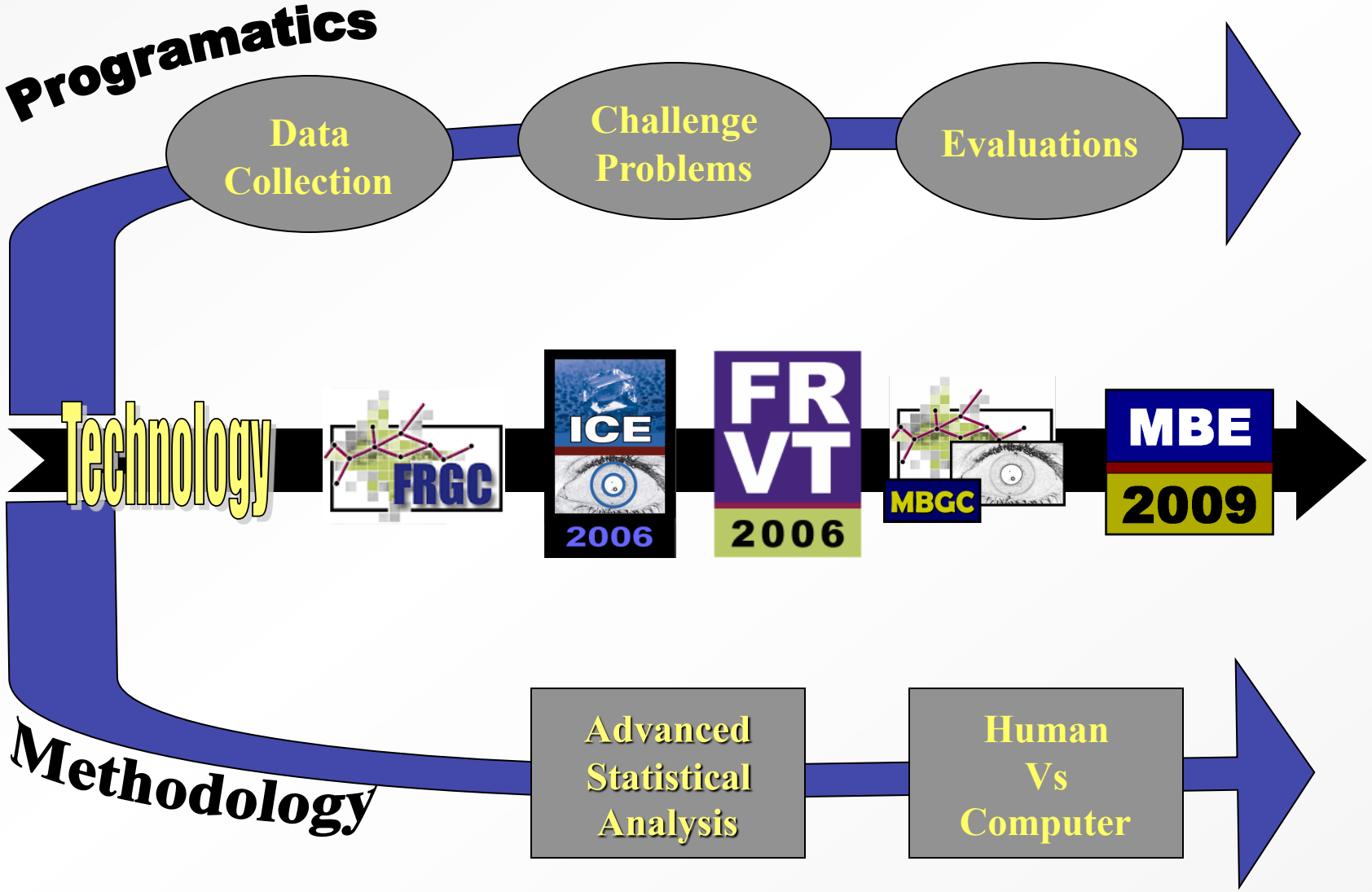


Single Still

Controlled

Different Days

Advancing Technology and Methodology



Methodological Progress

1994: First Modern Technology Evaluation

2001: Re-sampling Techniques

2002: First Evaluation with 100k+ samples

2004: Statistical Modeling

2004: Human & Computer Performance

2007: Iris Meta-analysis

2008: Covariate Focus on Quality

2009: Biometric Completeness

1993

Development

1996

FERET

2000

Facial Recognition Vendor Test 2000

FACE RECOGNITION VENDOR TEST 2002

2002

GAIT

2003

FRGC

2005

2006

FACE RECOGNITION VENDOR TEST 2006

ICE 2006

2009

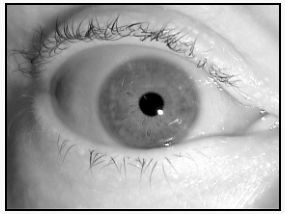
MBE 2009

2010

NIST

Challenge Problems

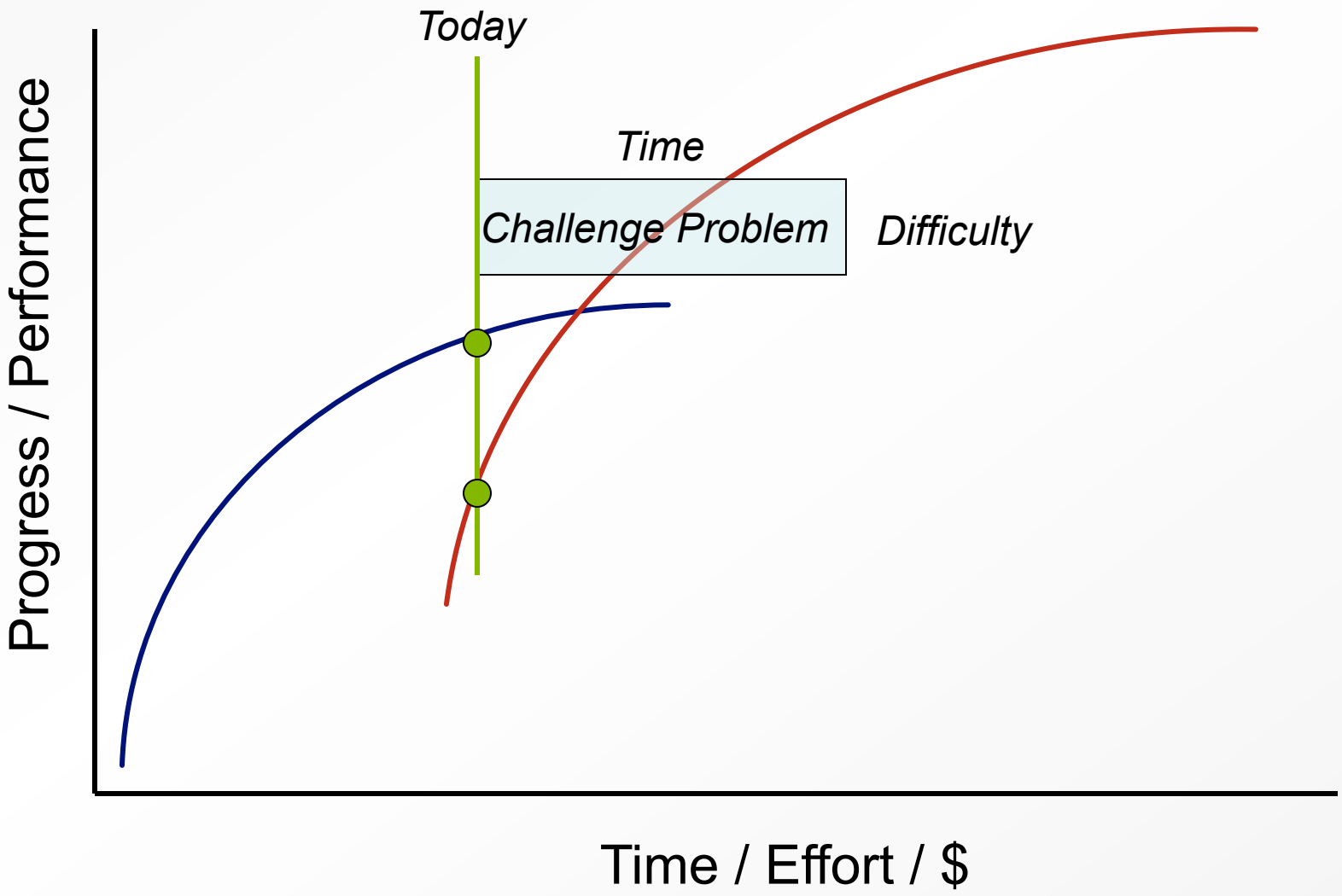
- What are challenge problems?
  - A series of experiments designed to advance a technology's state-of-the-art
    - Experiments designed
    - Experiments and test data distributed to researchers
    - Researchers complete experiments and submit results
    - Scores are consolidated and reported
  - Introduction of new technology



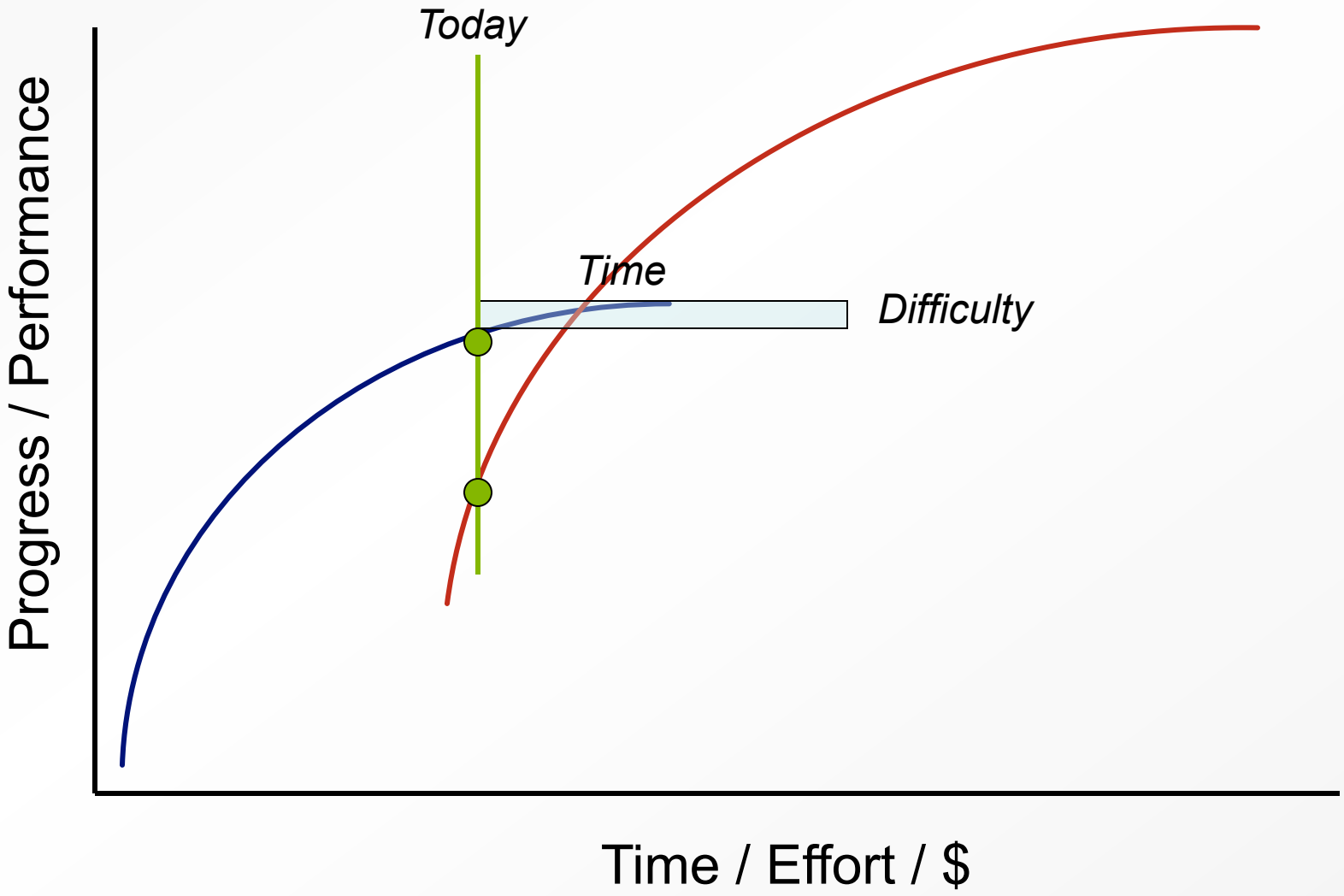
What Is A Challenge Problem?

- Challenge Problem
  - Open book
- Components—made available to participants
  - Data sets
  - Experiments
  - Ground truth
  - Baseline algorithm
- Similarity Matrices Submitted
  - Generated by participants
  - Scored by NIST
- NOT an independent Evaluation
  - NO sequestered data

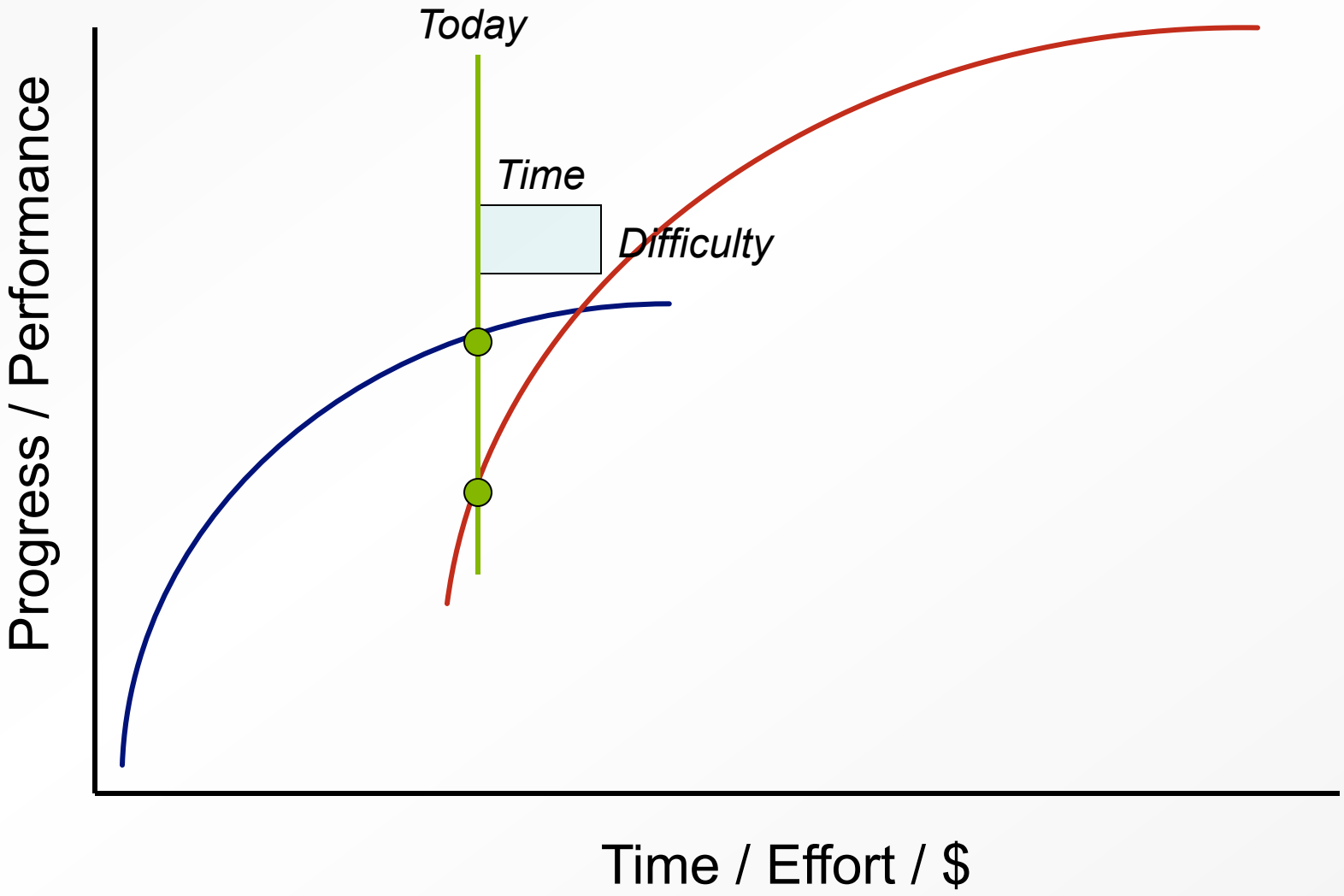
Ideal Challenge Problem



Challenge Problem Sin: Too Easy

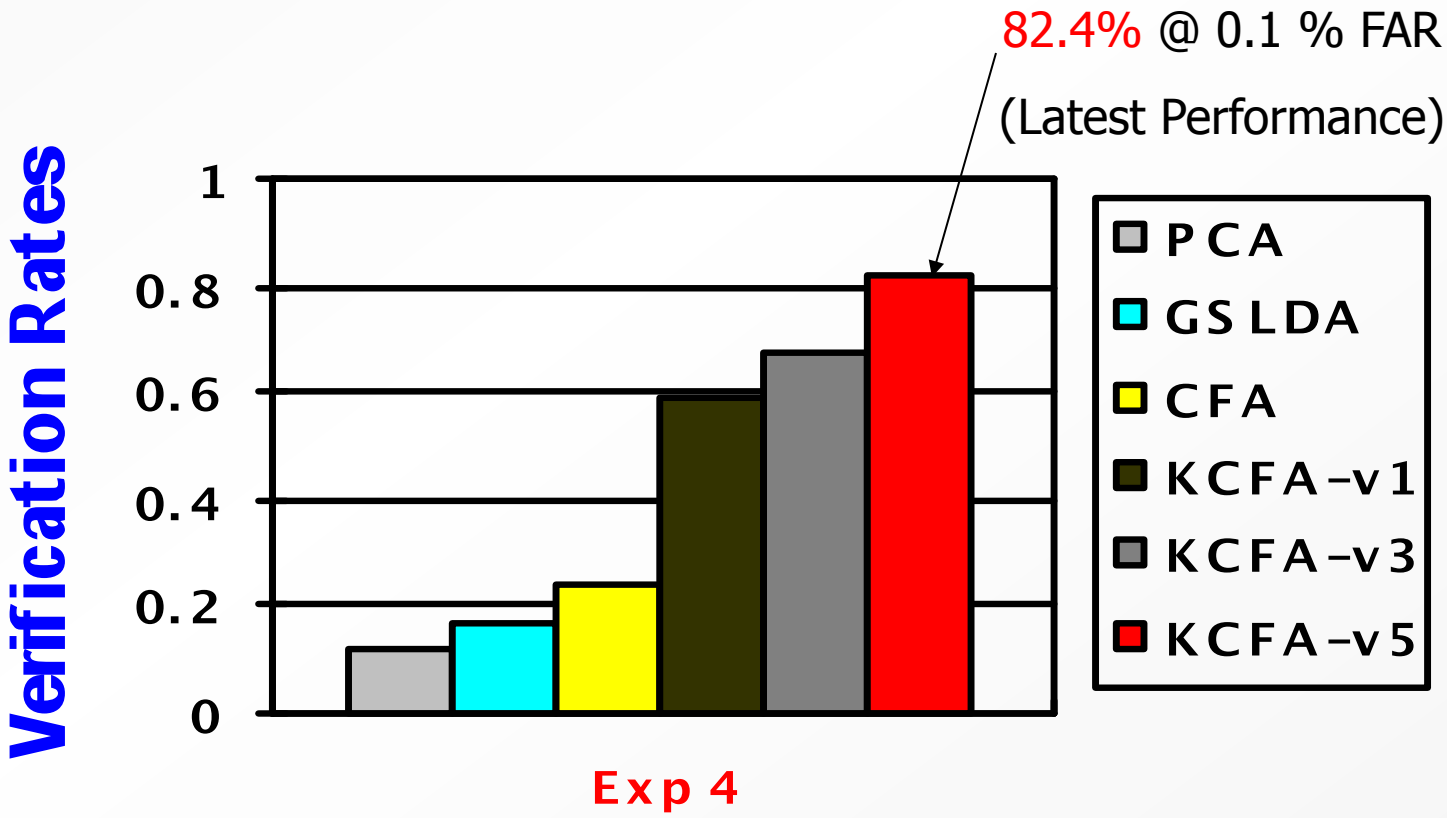


Challenge Problem Sin: Too Little Time



Evidence of Progress through FRGC

Carnegie Mellon Innovation



Building a Challenge

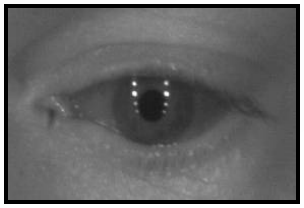
- Goals—Simple and grandiose
- Setting goals—Cheat
- Complete infrastructure for challenge problems
- Open to all

Expanding Technology

What Does Expanding Technology Do For You?

- Development of new or improved technology
- Focus research on challenge problem
- Large community working on problem
- Solutions from novel approaches

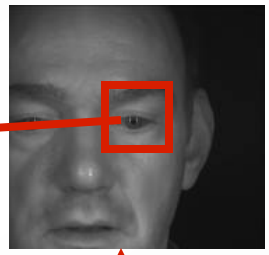
Portal Recognition Cont.



120 pixels across iris

2k

2k



Near Infrared (NIR) Video Sequence

High Definition (HD) Video Sequence

Example of Expanding Technology: Recognition from Unconstrained Video

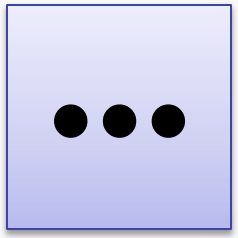
- Still versus Video

- Video versus Video

Expanding Science

What Does Expanding Science Do For You?

- Increases fundamental knowledge of biometric modalities.
- Human and computer performance
- Covariate analysis
- Analysis of results on large data set
- Underlying properties of a biometric

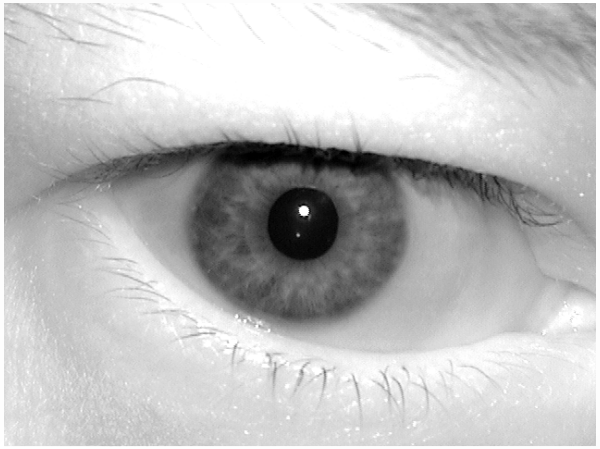


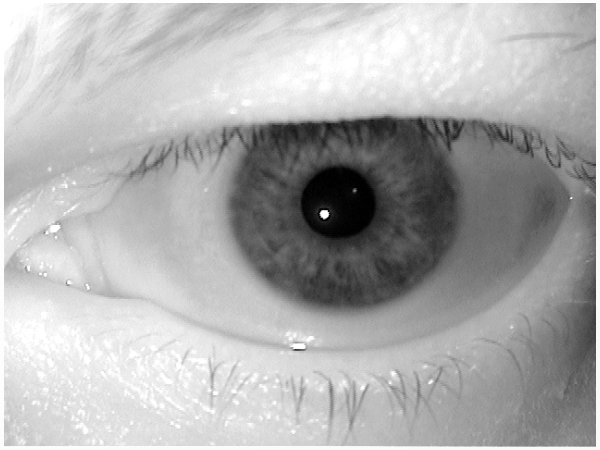
Example of Expanding Science: Iris Biometric Stability

"Empirical Evidence for Iris Match Score Degradation with Time Lapse in ICE 2006" S. Baker, P. J. Flynn, K. W. Bowyer, and Dr. P. Jonathon Phillips, *NISTIR 7630,* 2009

Motivation

- **Iris biometrics assumption: The iris is stable throughout one's life. Is this claim accurate?**





Introduction

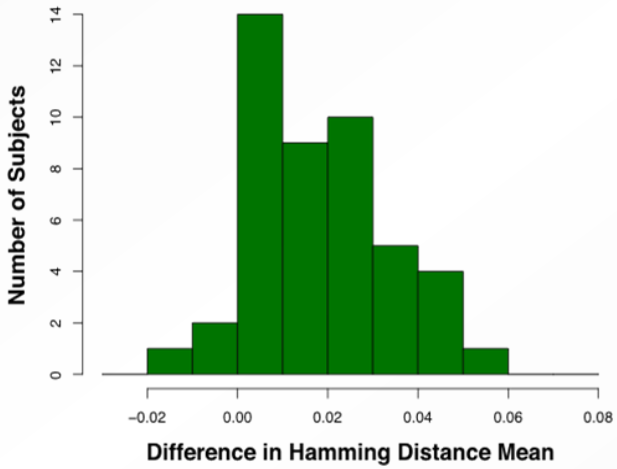
- 23 subjects
  - 46 irises
  - Collected 2004 through 2008.
- Three iris recognition algorithms
  - IrisBee baseline algorithm
  - ICE 2006 Algorithm B
  - VeriEye

Experiment

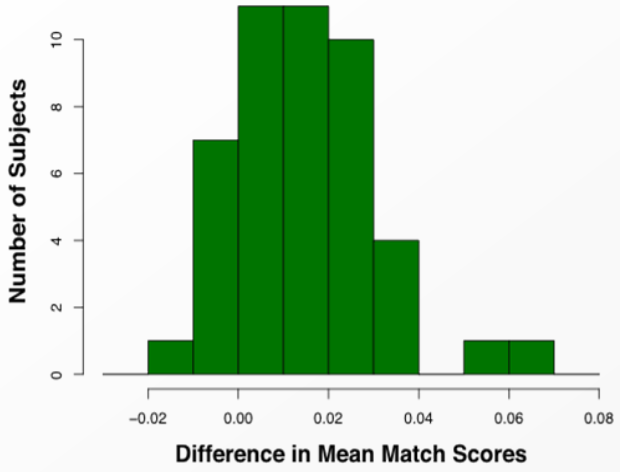
- Computed match (genuine) scores
  - for images acquired less than 120 days apart (short-time-lapse).
  - for images acquired more than 1200 days apart (long-time-lapse).
- Compared short-time-lapse and long-time-lapse
  - Mean of match score distribution
  - Median of match score distribution

Results

- **IrisBee** Algorithm
  - **43 of 46** irises showed degradation, p-value = 2.311×10^{-10}
  - mean match score
- **ICE 2006** Cambridge Cam-2 Algorithm
  - **38 of 46** irises showed degradation, p-value = 9.2477×10^{-6}
- **VeriEye** Algorithm
  - **40 of 46** irises showed degradation, p-value = 3.103×10^{-7}



IrisBee



ICE 2006 Cam-2

Iris Stability

- First study
  - One sensor
  - Limited subjects
- Recommend further studies
- Template aging as observed in other biometrics
- Multi-lab criteria

Conclusions

- Biometric technology has experienced significant progress over the last 15 years.
- Challenge Problems are Key for advancing the ‘State of the Art’.
- Science is Key to advancing Technology.

Questions?

Example of Expanding Technology: Portal Recognition